Synopsis

for

Ph. D.

Topic: **Studies on Ecology and Biodiversity of Butterflies and Moths (Lepidoptera: Rhopalocera and Heterocera) from different habitats of Bero Block of District Ranchi.**

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TITLE: STUDIES ON ECOLOGY AND BIODIVERSITY OF BUTTERFLIES AND MOTHS (LEPIDOPTERA: RHOPALOCERA AND HETROCERA) FROM DIFFERENT HABITATS OF BERO BLOCK OF DISTRICT RANCHI.

STATE OF ART:

Butterflies and Moths constitute a large group of arthropods, class- Insecta belonging to order- Lepidoptera. Order- Lepidoptera contains over 100 families of insects worldwide, some of which are moths and some of which are butterflies. However, there are some differences in physical and behavioral characteristics that are easy to learn and recognize. The most obvious difference is in the feelers or antennae. Most butterflies have thin slender filamentous antennae which are club-shaped (clavate) at the end. Moths, on the other hand, often have comb like (bipectinate) or feathery antennae. This distinction is the basis for the earliest taxonomic divisions in the Lepidoptera, separating them into the following two groups: The Rhopalocera –'clubbed horn' (Butterflies) & the Heterocera - 'varied horn' (moths). Most moth caterpillars spin a cocoon made of silk within which they metamorphose into the pupal stage. Most butterfly caterpillars, on the other hand, form an exposed pupa, also termed as chrysalis. There are many exceptions to this rule, however.

They vary in their shape, sizes, colour and wing span, etc. Among 200,000 known species of Lepidoptera (Vane Wrights, 1978), 10% are butterflies. Their characteristic feature is their colourful wings. They have slender bodies that are held vertically when at rest. They are diurnal. Indian subcontinent harbours around 1504 species out of 1700 known global species of butterflies (Varshnay and Smetacek, 2015), mostly found in the north eastern regions. Around 100 species are endemic out of which 26 taxa are threatened globally according to the IUCN red list of threatened animals and insects.The Zoological Survey of India has reported only 1,318 species of butterflies in India. The butterflies and moths are one of the most visible and functional species in the ecosystem (Larson et al. 2001). Butterflies have fine scales on their wings that look like fine powder. These scales are coloured and result in giving striking colors and patterns to many

butterflies while providing cryptic colors and camouflage patterns to others. When touched by humans, the wings tend to lose some scales. If too many scales are lost, the butterfly's ability to fly will be impaired. The scales on the butterfly wings have many properties, mostly optical, that interest scientist. The patterns they make are also seen as the best animal system for understanding the developmental and genetic processes that produce morphological variation in nature. Butterflies have been used as model organisms for a variety of fields of study, spanning ecology, evolutionary biology, and conservation biology (Boggs et al. 2003).

Butterflies are also known as the insects of sun because of their colourful wings, attracting and eye soothing nature. They act as pollinators for various plants and show co evolutionary relationship with plants (Tople et al, 2006). They vary in shape, size, colour and wing span. Their diversity and distribution vary according to climate, temperature, precipitation and topography. They also act as bio-indicators as they help in monitoring pollution levels and climatic change. Global climatic change has a very devastating effect on the diversity of butterflies as they are very specific in humidity and temperature requirements (Forister and Shapiro, 2003). Temperature and rainfall play an important role in their abundance (Pollard, 1988).

Recently there has been an increase in biodiversity study due to technological advancements and mobile photography, but butterflies have not yet received proportional attention due to their ubiquitous nature (Chandler et al, 2017). Even today there are many regions from where even basic information about their occurrence and abundance are not available.

Environmental variables play a key role in shaping the diversity of butterflies and moths communities. Temperature and vegetation cover are identified as crucial factors influencing species richness, while humidity levels correlated with the presence of specific moisture dependent species.

After going through several literature and journals, it has been noticed that several research works have been conducted in Jharkhand related to the

biodiversity and ecology of butterflies and moths fauna in diverse areas of Jharkhand, which includes localities of forests, wetlands, and vegetation surrounding a particular area of a town or village. Some examples of research works in Jharkhand are- Species diversity of butterfly in selected area of Ranchi, District (Nirmala Kumari et. al,2024); Butterfly diversity of Biodiversity Park, Ranchi(Nirmala Kumari et. al,2023); Seasonal dynamics of butterfly communities in different habitats of Ranchi (Niharika et. al, 2024); Butterfly diversity of reclaimed over burden dumps of kithara coalmine area, Jharkhand (Amita Hembrom and Braj Kishore Sinha, 2012,); Impact of some ecological factors on the diversity of Creatonotus transiens walker (Lepidoptera: Noctuidae) at Ranchi, Jharkhand (Anand Kumar Thakur, 2016); List of Lepidopteran insects from Palkot Wildlife Sanctuty, Jharkhand (Navneet Sigh and Jameel Ahmad, 2017). After going through above works, it was noticed that although several work has been done related to the survey and biodiversity and abundance of butterflies and moths species in Jharkhand, but no such work has been reported in Bero block. So, this research work would explore the butterfly and moth diversity and abundance in this area and it will help to fulfil the research gap created due to non investigation.

PROBLEMS TO BE INVESTIGATED:

1. Study of biodiversity and species richness of butterflies & moths (Lepidoptera: Rhopalocera and Hetrocera) from different sites and landscape viz. rice fields, rural and forest areas, grassland wetland, bushes of Bero block , District Ranchi will be investigaed.

2. Morphometric features such as size, wing span, venation of wings, antennal features for taxonomic discrimination of recorded species of butterflies and moths will be studied.

3. Identification of very common, common, rare, endemic and any new species.

OBJECTIVES :

1. Survey, collection and preservation of different species from the aforesaid area.

2. Investigation of species diversity, species richness, dominance and abundance and dynamics the selected area.

3. To study morphometric features of each species.

4. Identification of rare and endemic species .

HYPOTHESIS:

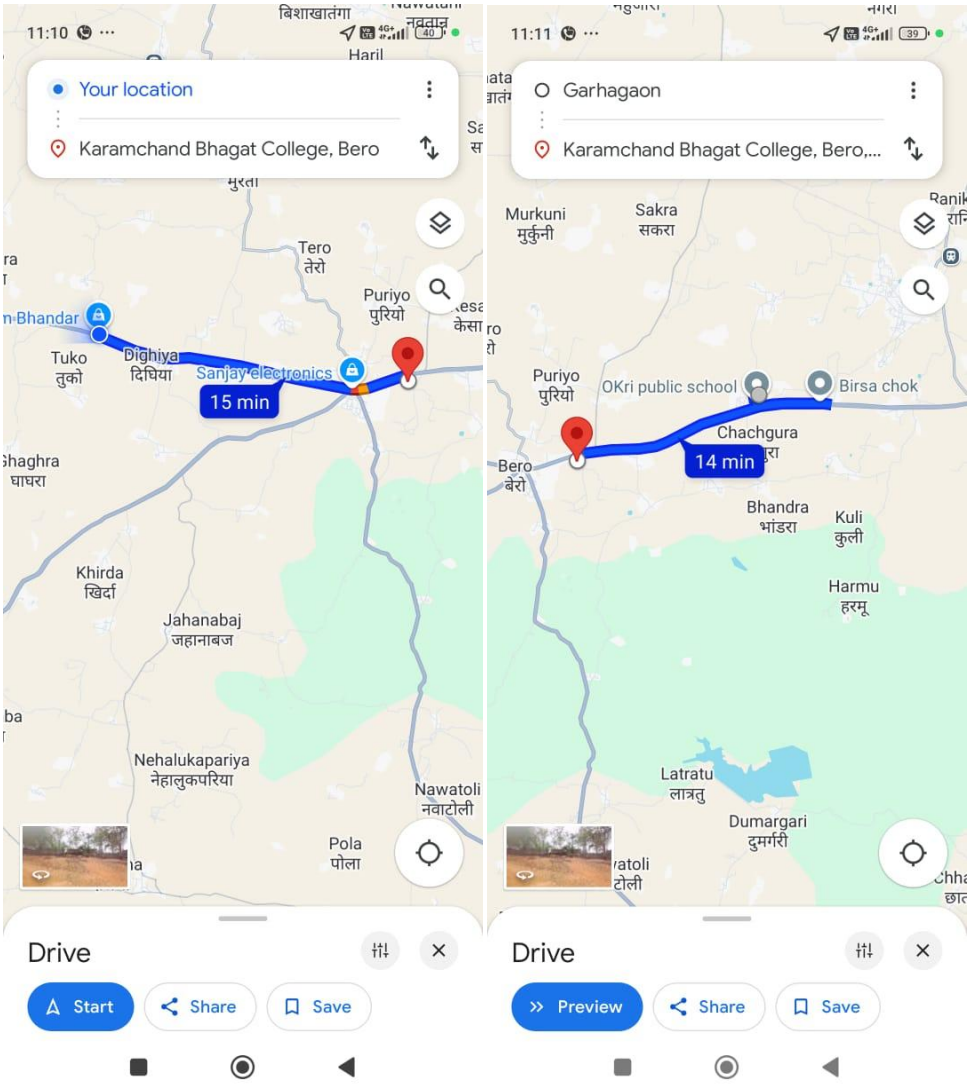
1. The main aim of this work is to find out whether the diversity of species of butterflies and moths of this study areas / rural landscapes is different from other areas of Ranchi district or not.

2. If some species of butterflies and moths are present in these areas which were declared critically threatened/endangered according to IUCN Red List.

3. As the selected area is rich in forest and greenery we are expecting more diverse species of butterflies and moths. All these will be tested by the real data that we obtain after sampling.

RESEARCH DESIGN AND METHODOLOGY:

A field survey will be conducted across the various chosen habitats and landscapes representing distinct ecological characteristics capturing unique floral resources, structural complexity and microclimatic condition at about 10 k.m around the Bero Block. The selected site will be visited at frequent intervals in all seasons (1) Winter- October to January (2) Spring- February to March (3) Summer- April to june (4) July to September to observe the presence or absence of butterflies and moth fauna in the selected area of research. A thermometer and hygrometer will be placed within each area of sampling to record temperature and humidity at every 20 minutes interval throughout the study period as seasonal fluctuations directly influence butterflies and moth activity and thermoregulation.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(a) Butterfly Sampling:-

Butterflies will be collected with the help of hand seeping insect nets (both ground and aerial net sweeping) unidentified species will be collected and killed using benzene in a killing jar and processed as per standard techniques in Lepidopterology while rest will be released after taking photographs and morpho metric measurement .

Pollard Walk butterfly species composition and their relative abundance will be sampled using transect counts modified from Pollard (1977). Pollard walk surveys employ fixed travel routes during counting. We shall record butterflies observing within the five meter band on both side of transect, while walking at a slow and steady pace. Species identification will be made visually or using binocular when needed, photography or videography using camera of good quality. Occasionally identification to be made capture with sweeping nets after which insects will be released unharmed. Transect to be walked between 10.00 a.m to 3.00 p.m at least one day during 10 days of sampling period. Sampling will be restricted to relatively calm conditions and times, when air temperature exceeds 13^0C in sunny weather or 17^0C in cloudy weather.

We will record all butterflies seen within a closed area covering five meter width on both side of transect and five meter ahead of individual. So, we will record all butterflies moving within this five meter box. No special efforts will be made to record butterflies settled out of sight in dense vegetation. We shall record each individual once only. We will also keep the records butterflies behaviour and interactions with their environmental, it will provide more holistic picture of their ecological role.

(b) Moth sampling and identification:

We will employ a stratified random sampling framework, *i.e.*, random samples will be taken from aforesaid areas . Moths will be collected using a light trap running for 4 hours, from 7 pm to 11 pm, in the four seasons as mentioned above. Light traps will be set using a solar powered lantern or gas lamp or rechargeable LED light in front of a white cloth sheet approximately 8' x 6' of size hung between two vertical poles in such a way that it touches the surface and extends forward over the ground slightly. After specimens collected, they will be killed using benzene in a killing jar.

The collected specimens will be processed for pinning, setting and preserving in air tight wooden boxes. The specimens will be first sorted on the basis of morph metric features and later identified with the help of the available literature and by comparison with the reference collections available at the Zoological Survey of India, Kolkata. For taxonomical identification we will mainly follow Richards, O.W., Davies, .R.G. IMMS' General textbook of Entomology. Volume-II (Tenth Edition); Hampson (1892, 1894, 1895, 1896) and subsequent changes in the families based on Kirstensen (1999); Harold Maxwell- Lefroy and F.M.Howlett. Indian Insect Life; Brooks and Knight,185; Kunte, 2000 and Kehimkar, 2000; Bell and Scott,1937, Matcaff and Flint,1939; Pradhan,1994; Zahradnik and Chvala (1989). The unidentified specimens will be sent to the national repository at the Zoological Survey of India. The rare unidentified species will be subjected to DNA analysis through outsourcing a laboratory, if needed.

STATISTICAL ANALYSIS:

The diversity and generic abundance will be determined for four seasonal months and for overall sampling too. Richness, diversity, dominance and abundance of the recorded butterfly species shall be determined through Shannon index (Shannon and weaver, 1963), Dominance index (Berger and Parker, 1970), Simpson's diversity index and Simpson's index (Simpson,1964). Species evenness will be determined through Pielou's evenness index (Mulder et al., 2004). A rank

abundance curve will be prepared to explain species richness as well as species evenness (Whittaker, 1965).

The following diversity indices will be used for statistical analysis for collected species.

(i) Shannon-Weiner diversity index: It will be used to measure species diversity in a community. The species diversity can be measured by using formula provided by Shannon-Weiner, which is as follows:

$$\mathbf{H = -\sum pi * In(pi) \quad or \quad = -\sum pi * log.pi}$$

Where, H= Species diversity index

Pi = ni/N is the proportion of individual of each species belonging to the i^{th} species of the total number of individuals.

ni= number of individual of one species in a sample.

N= total number of individuals in a sample.

In = Natural log

log.pi = logarithmic value of pi representing the richest of species (mean of individual species) .

The higher the value of H, the higher the diversity in a particular community. The lower the value of H, the lower the diversity. A value of H = 0 indicates a community that only has one species.

(ii) Shannon-Weiner Equitability index: It is a way to measure the "evenness" of species in a community. The term "evenness" simply refers to how similar the abundances of different species are in the community. It is donated as " E_H". This index is calculated by –

$$\mathbf{E_H = H/ In(S)}$$

Where,

H = Shannon-Weiner diversity index

S = Total number of unique species.

In = Natural log

This value ranges from 0 to 1 indicates complete evenness.

(iii) Relative abundance index: this index is used for measuring the species diversity of a community and is calculated by following formula:-

R. A.= n_i /N * 100

Or, p_i *100

Where,

ni= number of individual of one species in a sample.

N= total number of individuals in a sample.

Pi = ni/N is the proportion of individual of each species belonging to the i^{th} species of the total number of individuals.

(iv) Rank abundance diagram similarity and dissimilarity through Jaccards Co-efficient :

It is calculated by formula-

$$Cj = J/a+b+j$$

Where,

a = the number of species in habitat A.

b = the number of species in habitat B

j = the number of species common to both habitat taken.

(v) Simpson's diversity index will be used for richness of each species in the population in the given area at a given time. It helps in the study of biodiversity of different species in the given area.

We shall try to establish the relationship between species abundance and environmental variables. Correlation of ecological factors (average temperature, precipitation, humidity and pesticide application) will be studied and their relation with species richness and diversity will be established.

All the diversity indices will be analysed and calculated with the help of Microsoft Excel 2019 Software.

STATSTICAL TOOLS TO BE USED:

Insect net, Wing spreading tool, Camera, Killing jar, Insect box, LED Light, White cloth, Microscope,

SIGNIFICANCE OF THE STUDY:

1. Butterflies are the indicator species as their diversity and abundance reflect the health of a habitat and as a tool for monitoring the impact of urbanisation in an area.
2. This work will able to understand and provide valuable information about variation in species richness, diversity and abundance across season and habitat types.
3. It will certainly enhance our understanding of butterfly assemblages in the study area and provide a basis of planning conservation strategies.
4. Investigating the specific ecological interaction among butterflies or moths, host plants and predators would expand our understanding of their community dynamics.

RELEVANCE TO THE PRESENT DAY PROBLEM AND NEED OF THE SOCIETY:

The present research work can enable to study the natural habitat of the butterflies and moths in rural and semi-urban areas. It will help to design conservation plans and management strategies for the protection of endangered species of butterfly fauna and their habitats. It will also help to estimate the diversity and abundance of butterflies and moths in these areas and know the impact of urbanisation on their population.

CONTRIBUTION TO THE EXISTING KNOWLEDGE:

In Bero and its adjoining area no work has been reported on the biodiversity of butterflies and its abundance. This project will certainly help us to study the diversity of butterflies and prepare an inventory of butterflies through their identification, conservation, distribution as well as the effect of different ecological factors. The exploration of butterfly fauna now has become an important tool for environmental monitoring and assessment. High abundance of butterfly characteristically indicates the habitat is an improved ecological unit (Roy, 2022). Urbanisation is associated with habitat degradation, habitat modification and alteration in local climatic circumstances, which has adverse effect on plant species diversity, on ground water and soil quality (Singh et al.,2009; Garg et al., 2009). Hence, urban development negatively affects nature biodiversity (Malagrino et al., 2008). This research work will provide valuable information related to seasonal dynamics of butterflies and moth communities in Bero's diverse habitat.

FUTURE WORK:

In future, in continuation of above work, our aim will be to conduct more survey on abundance and biodiversity of more insects of different orders like Coleoptera (beetles) Hemiptera (bugs), Orthoptera, Dictyoptera etc in different habitats, rural landscapes and forested landscapes of Bero block.

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